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On the origin of steep edges and filaments in vorticity and potential vorticity fields.

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High-resolution numerical calculations are shown which capture the fundamental process responsible for the intensification of vorticity gradients in an isolated vortex subject to externally imposed disturbances. Imposition of almost any weak strain or shear field--we concentrate of "large-scale" fields having no spatial scale selectivity--succeeds in stripping away the relatively weak vorticity at the edge of the vortex and leaves it with gradients four to six orders of magnitude greater than in the initial state. Calculations displaying such enormous gradients have never been reported previously, because of the artificial eddy diffusivities that always limit such gradients in standard numerical models. The present calculations, which have no such limitations, have been made possible by the development of a novel and robust new numerical technique for vortex dynamics called "contour surgery".